Comité Asesor Científico y Técnico de la Cooperativa de Armadores de Pesca del Puerto de Vigo (CACT-Arvi)

REPORT ON FISHERIES MANAGEMENT IN INTERNATIONAL DEEP SEA WATERS AND ITS BIODIVERSITY CONSERVATION.

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BACKGROUND

On the 1st July 2016 Mr. Jose Antonio Suarez Llanos, General Manager of the Shipowners' Cooperative of Vigo (ARVI), and Chairman of its Scientific and Technical Advisory Committee (STAC) addressed a request to the experts of this Advisory Committee to draft a report in relation to the future fisheries management in international deep seas, including for this purpose the FAO draft on "*Analysis and guide for the implementation of international and policy instruments related to deep sea fisheries and biodiversity conservation in ABJN (Areas Beyond National Jurisdiction)"* of 27th June 2016.

Given the biological and technical repercussions for the Spanish high-seas fleets relating to fisheries management of this international regulation proposal, the STAC members who are more experienced in this subject from a scientific-technical perspective, were contacted in order to prepare the following ad-hoc report for ARVI thereon.

Content

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A. General and politic aspects.

i. The political importance of the FAO draft report mentioned in the "Background" section is that these initiatives force the EU and the International Waters Fisheries Administrations (International Fisheries Organization, the RFMO) towards its implementation given the increasing growth of environmental concern in developed societies which today are very informed and influenced by the media and international NGOs in terms of environmental and biodiversity protection in general and in particular that of the marine environment.

ii.- The indications in the previous point increasingly constrain international fisheries management decision-makers as well as the people representative bodies (National and EU Parliaments), greatly influencing the international legal rules that are finally approved. The vector "NGO> Media> Public> Parliaments> EU and national governments" increasingly works with more demanding and efficient mechanisms, thus conditioning the binding rules for States and consequently their fishing fleet.

iii.- On the issue we are dealing with in this report related to fishing in deep-sea waters outside (and inside) the exclusive economic zones of the European Union and coastal States in all seas and oceans, the above two points are further strengthened by what we might call a "defenseless of biodiversity" inhabiting in those waters in face of the fishing industry and the governments of the coastal states, the European Union and International Fisheries Organizations, on the one hand and on the other hand, because they spread over the deep-sea waters where especially sensitive or vulnerable species live on the seabed due to their biology (reproduction, growth, ecology). Also, sedentary species such as cold water corals and other organisms, which are especially sensitive to human action due to their very slow growth. Therefore, species living in deep-sea waters require management measures adapted to their special biology.

iv.- The reception of the draft report that has now been circulated by FAO has a long track record in scientific and international management organizations, which have issued important documents on this subject previously: The National Assembly of the United Nations, the World Sustainable Development Summit, the FAO itself, the Regional Fisheries Organizations such as NAFO, NEAFC, GFCM, ICCAT, SEAFO, CCMLR, GFCM international organizations such as IUU-Fishing, CITES, IMO, IPOAs, OSPAR, ICES and others. All of them have showed concern about the

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fishing control of free waters in general and in particular in deep-sea waters, promoting and urging compulsory international management.

v.- The European Union, starting from the Parliament and following the Commission as its management body, has been maintaining this issue in its agenda for many time, showing its usual desire to take the lead worldwide in the environmental defense linked to fisheries management (with continuous pressure, as we mentioned above, by the Parliament and the NGOs, about which they were so sympathetic particularly the former DG-MARE Commissioner and many European Members of Parliament, especially those from States less interested in those fisheries). Governments of countries without fishing interests in the areas under this debate, i.e. NAFO, NEAFC or the SW Atlantic of much interest to the Spanish distant water fleets, easily fly the environmental flag or "get profile" in cases like the one being dealt with in this report.

vi.- For decades, the Spanish fishing industry has have important interests in various deep commercial fisheries where species of high commercial value are caught, such as Greenland halibut and others in the NAFO area, adult hake, monkfish, Norway lobster and others in the NEAFC, toothfish and cephalopods in the ICSEAF (Southwest Atlantic), and others including crustaceans in archipelagos and cliffs in platforms within our EEZ and territorial seas.

Authors' Note: The above first six points affect and will continue to affect this debate and are a handicap for sincere, rational, scientific and dispassionate discussions, often giving rise to decisions taken "for show". They should be taken into account by representatives of our country (both from the fishing industry and administration) at informal and formal debates held in various forums. If necessary, this should be placed both on the table and in the normal and very important outdoor discussions that are previously held.

vii.- As a consequence of what is stated in the above points, the EU trialogue (Commission, Council and Parliament) recently reached an agreement to ban trawling below 800 meters depth in all EU waters, which is only subject to formal ratification and entry into force.

viii.- In our opinion, this EU agreement lacking a sound scientific base that includes a case-by-case scientific and technical analysis to indicate potential adverse impacts and the right quantification of the different fishing gears in the different areas

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involved in these sea bottoms is a bad precedent and means a first step taken by the EU to support future extensions to other areas of the global seas and oceans such as NAFO, NEAFC, and further distant waters with important historical economic interests for the Spanish fleet, which should also be put on the table.

ix.- It follows that it will definitely be, once again, a difficult struggle for Spain (Administration and fisheries sector), since it cannot count on the support of the various EU or other EU countries institutions and stands in front of the forehead of NGOs and States with lesser fishing interests, or higher interest in getting along with citizens (voters) of their countries. But all this should not be an obstacle to attend subsequent discussions with as much robust analysis and reports as possible to prove the knowledge on Spanish marine and fishing research, including bibliographic references, that our country through Spanish marine and fisheries researches has about these outmost remote areas from the coast, its active participation for decades in the Scientific Committees of the RFMO affected, the ongoing provision of information, publishing of scientific papers, development of annual observing schemes on board the fishing vessels, research and mapping campaigns of vulnerable and particularly sensitive sea bottoms from an ecological point of view, aiming at contributing to the analysis of their protection internationally. The State agency responsible for the Spanish fisheries research, according to the State Maritime Fisheries Law in force and the Institution's Statute itself, is the Spanish Institute of Oceanography (IEO). In the recent decades it has made a commendable and important effort in researching potentially vulnerable marine ecosystems in various parts of our planet, with an important contribution of highly qualified and experienced staff in this type of sampling, oceanographic ships and state-of-the-art technologies as well as a high economic investment sustained over the years despite the recognized economic and staff constraints during the last five years.

x. As indicated at the end of the previous point, it is fair to point out the activities in NAFO 3NO Zone since 1995, 3M Zone since 1998, Flemish Cap areas since 2003, off the Patagonia coast, NEAFC Hatton Bank since 2005, Cantabrian submarine canyons and Galicia grounds. Special mention should be made of the work done by the IEO on the Antarctica platform facing the Atlantic, which despite management difficulties apparently insurmountable, were commendably coordinated by the researcher Ms. Ana Ramos who is today working at the Oceanographic Center in Vigo and simultaneously teaching in marine benthos at the University of that city in Galicia. Since the 90s of last century successive multiannual, multidisciplinary and

multi-institutional programs under the Spanish National Research and Development Plan were made. Dozens of scientific projects were covered. These projects involved a recognized team of researchers and technicians from the IEO and other national and foreign research centers, who knew the techniques for studying benthic ecology, cold water corals, protection of vulnerable marine ecosystems and the biology and ecology of deep sea living resources and used the most modern sampling and underwater observation techniques with robots equipped with sensors using articulated sampling arms and high resolution underwater cameras, reaching depths below 1,500 meters. This has enabled, with the scientific advice of the IEO, to propose protection of specific vulnerable marine ecosystems areas to the Spanish government and international organizations.

xi.- In our opinion all these papers that were presented at international forums and the high investment Spain had to support and still continues to support, as well as the resulting important outcome that were published should be communicated and put into value at international meetings on the subject by the representatives of the Administration and the fisheries sector (Ministry of Agriculture, Food and Environment, Xunta de Galicia and other Governments of the Autonomous Regions, Advisory Councils of the EU Commission, CEPESCA, ship-owners associations, etc.). Therefore, the aim should be that management measures that are finally adopted are based on data and scientific papers where the analysis is made area-by-area and case-by-case, thus avoiding generalities and feelings, and restricting the invocation of the precautionary principle only to specific cases with proved ecological risk. The Annex to this report includes, as an example, an international scientific publication on this research by Mr. Pablo Duran, scientist of the IEO Vigo Oceanographic Centre.

xii.- The first part of the FAO draft report mentioned in the beginning makes a review of the existing legislation (either mandatory by the UN, RFMO, etc., or recommendations from the FAO or similar organizations). The review seems to be very complete; however it simply summarizes what already exists. The second part is a "step by step guide" to transpose international law into national legislation. It is a useful guide, but in Spain that transposition is already done systematically, as it is done in relation to the European regulations. Actually, the EU legislation, since it is adopted and published in the Official Journal of the European Union, is binding on Member States even in the absence of that transposition.

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xiii.- Based on what has been expressed so far it is time now (although it should have occurred better some months ago, actually), to provide input to the draft to be defended at the debates prior to its potential approval by the EU, both in professional bilateral forums and in the meetings of the Spanish fisheries and environment Administration with the participation of CEPESCA, for example, as well as in bilateral meetings with the representation of Spain in Brussels, with the Commission DG MARE, Spanish MEPs, Ministries of Fisheries of the coastal Autonomous Communities, etc.

Authors' note: Perhaps an analysis should be carried out of the available information to estimate of economic, social and international relations implications of these new legislations for the Spanish fleet.

B. The report on the "Guide for the management of areas beyond the limits of national jurisdiction".

To the aforementioned "*Draft Analysis and Guide for the implementation of international and policy instruments related to the deep fisheries and biodiversity in ABNJ*", which is the subject of this report, we provide the following additional considerations:

i. After reading carefully the aforementioned draft, firstly we note that the "purpose of the Guide," turns out to be: "Identify the range of instruments that may be relevant for deep sea fishing and its impacts on marine biodiversity beyond national jurisdiction with a view to providing advice to States on the steps that may be necessary to implement these instruments at the national level".

ii.- It goes on saying that "there is no single definition of fishing or deep-sea fisheries used internationally", but it reminds that the FAO "International Guidelines for the management of deep-sea fisheries on the high seas" apply to "fisheries in which the total catch (by-catch) includes species that can withstand only low exploitation rates and in which fishing gears often have contact with the seafloor during the normal course of fishing operations" and that this definition will be used in this "Guide". The consequences of this definition should be analyzed in depth for its very likely impacts on the Spanish fleets.

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iii.- The "Guide", as aforementioned, has two parts: The first part provides a detailed review of international instruments (whether mandatory or just recommendations) that are important for the conservation and management of deep-sea fisheries and associated ecosystems . The review seems magnificent, but it simply summarizes what there already exists. The second part provides a step by step guide to move international law into national legislation. It is very useful, but in Spain a systematically transposition is already done. It seems to us that the sentence should be primarily addressed to countries having transposition problems into national legislation. In any case this question would deserve a legal expertise contribution in this area.

iv.- Regardless of the explicit contents of the "Guide" there are two remarkable points that may be in the future regulation process of Deep-Sea Fisheries: The definition of deep-sea and the basis for the protection of Vulnerable Marine Ecosystems with mechanisms scientifically validated and internationally accepted by decision-making bodies on management measures.

v.- Deep-sea definition: As indicated in the draft "Guide", there is no single definition of "deep-sea waters" accepted internationally, In each field a different limit depth is usually applied taking into account scientific criteria or other information available on the environment in question. For example, NEAFC, as indicated in the draft, usually uses 400 meters depth to define deep seas based on ICES advice. However, the Trilogue of the European Union has just reached an agreement to ban trawling below the 800 meters depth in EU waters. By recently deciding on considering 800 meters as a boundary to define deep-sea in their own waters the EU Trilogue will most likely try to keep the same limit in waters beyond national jurisdictions or European Union, or other RFMO, which will certainly have negative impact on Deep-Sea Fishing, the general trend being aimed at the protection of Vulnerable Marine Ecosystems. Such trend can be read in the section on Vulnerable Marine Ecosystems of the FAO "International Guidelines for the management of deep-sea fisheries in high seas". Several research institutions in countries around the world are carrying out researches on this subject in a number of important fisheries for Spain like NAFO and NEAFC to put as an example in the North Atlantic fisheries.

vi.- Deep-sea limits as a base for the protection of the VME: The choice of 800 meters depth by the Commission is probably based on an interpretation of the work "*A scientific basis for regulating deep-sea fishing by depth*" by Jo Clarke et al.,

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researchers from Glasgow and Aberdeen, UK. A novel technique using data from deep trawling scientific campaigns in the NE Atlantic is used to show the depths from which the ecological rates and catch value change significantly. The results of these British scientists suggest that between 600 and 800 meters commercial fishing benefits begin to be outweighed by the potentially negative ecological consequences.

vii.- In the opinion of the authors of this report of the ARVI's Scientific and Technical Committee, it seems to us to be very difficult to make a comparison between the ecological importance of such broad areas and different geographical locations in different seas and oceans of the world, and the economic value and social development of fishing in the same areas. The message we draw from what has been said is that it will be necessary to have scientific and analytical information and publications that become the basis for the decision-making bodies since they should make the decisions, in our opinion, using the best scientific information available as we have indicated in the above points of this report.

C. Protection of Vulnerable Marine Ecosystems regardless of the depth definition.

i. In Spain, as it has been detailed previously, the Spanish Institute of Oceanography has made a significant research effort on this type of sea bottoms with ecological interest. Surely they are of special interest to ARVI research carried out in areas of Hatton Bank, on the continental shelf and Patagonian slope off the 200 miles of Argentina, on the banks of Valdivia and Ewing Seamount and in the NAFO area.

ii.- Deep waters are the largest ecosystem in the world with a high level of biodiversity and many species that have certain characteristics of their life cycle that make them vulnerable to high levels of exploitation. Many deep-sea fisheries have a history of being unsustainable. In the Northeast Atlantic there has been a decrease in the abundance of commercial fish species since the deep sea fishing began in the early 70's. Current management is carried out through effort restrictions and the total allowable catch (TAC), but there are still problems with compliance and high levels of bycatch of vulnerable species, such as sharks. The European Union is currently considering new legislation to manage deep-sea fisheries, including the introduction of a limit depth for trawling. However, there is little evidence to suggest an appropriate depth limit.

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iii.- Data from scientific campaigns were used to know and demonstrate that the biodiversity in demersal fish community, both the proportion of biomass discarded with respect to commercial biomass and the proportion of elasmobranchs (sharks and rays) with respect to commercial biomass increased significantly between 600 and 800 meters deep, while the market value decreases.

iv.- This set of results suggests that limiting trawling at a maximum depth of 600 meters could be an effective management strategy that may adapt to the needs of European legislation, such as the Common Fisheries Policy (EC no. 1380/2013) and the framework Directive on marine strategy (2008/56 / EC).

v.- Summary available on Spain research on this topic and its achievements: The current Director of the IEO, Mr. Eduardo Balguerías made a magnificent presentation with a summary of the historical results of these investigations at the "Third International Conference on the Future of Fishing organized by ARVI "(Vigo, 16th June 2016). We think it would be helpful that either CEPESCA or ARVI ask the Director of the IEO, either directly or through the General Secretariat of Fisheries, a summary of these investigations, an assessment of the results and a proposal to continue these investigations and that same are funded by the relevant Ministries of the Spanish Governments, both that that is about to be constituted and the following one.

vi.- The purpose of the future deep-sea regulations: The document we are analyzing throughout these points says it is a question of achieving an efficient and sustainable use of living resources in the high seas and the conservation of biodiversity through the systematic implementation of ecosystem approach with the objectives listed below.

D. Objectives of future deep-sea fishing regulations:

i. Improve practices for sustainable management of deep-sea fisheries, taking into account the related impacts on ecosystems;

ii.- Protect Vulnerable Marine Ecosystems and Significant Ecologically and Biologically Areas**;**

iii.- Conduct an improved area-based planning practice for deep-sea ecosystems.

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iv.- Verify and provide planning tools based on efficient methodologies and areas included in the "*Regional Seas Programmes*" and RFMO,s programs to develop regional policies and management plans**.**

Author's note: The Organizations affected by future international management of EMV are the RFMO, the European Union and therefore its Member States. Other organizations directly concerned and involved in this issue are the Regional Organization for the Management of Deepwater Fisheries, the South Pacific Permanent Commission, Regional Coordination Unit for Eastern Africa, the IUCN, the Convention on Biological Diversity, and the relevant organizations of the fishing industry.

E. Scope and principles of the "International Guides for the management of deep-sea fisheries in the high seas".

The "Guides" as they are called, have been developed for fishing carried out in areas that are outside national jurisdiction with the following characteristics:

i.- The control must be comprehensive to all fishing vessels whose fishing gears are likely to contact the seabed during normal performance of fishing operations.

ii.- Total catches must be it literally (absolutely everything caught with the fishing gears) especially including species which can only support a low rate of exploitation according to the biological information.

iii.- In these cases the affected States and RFMOs should consider, as appropriate, the application of the elements included in these guidelines to similar fisheries in areas beyond national jurisdiction, including species accounting for medium productivity.

iv.- For the purposes of these Guidelines, the described fisheries will be called "deep-sea fisheries".

v.- Coastal States may apply these Guidelines within their national jurisdiction, as appropriate.

vi.- The main management objectives of DFP are to promote responsible fisheries that provide economic opportunities while ensuring the conservation of living marine resources and the protection of biodiversity in the marine environment.

vii.- To that end they should ensure long-term conservation and sustainable use of marine living resources in deep waters.

viii.- Significant adverse effects on marine ecosystems shall be always prevented.

F. Methods to achieve the stated objectives, States and RFMOs should adopt and implement appropriate measures:

i.- In accordance with the precautionary approach, as is reflected in Article 6 of the 1995 United Nations Agreement on Fish Stocks and described in Articles 6.5 and 7.5 of the Code of Conduct for Responsible Fisheries (the Code).

ii.- Under an ecosystem approach to fisheries (EAF).

iii.- In accordance with the relevant rules of international law, particularly as reflected in the United Nations Convention of 1982**.**

iv.- Consistent with other relevant international instruments, identifying areas where EMV are known to exist or likely to exist and adopting measures using the best information available.

G. "International Guidelines for fisheries management in deep-seas".

This guide provides a complete description of the fundamental concepts, starting with an explanation of the characteristics of species exploited in these ocean bottoms:

i. Many marine living resources exploited by the DFP have biological characteristics that pose specific challenges for sustainable use and exploitation. The following examples can be mentioned:

- Maduration at relatively advanced ages,

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- Slow growth,
- Long life expectations
- Low natural mortality rates;
- Intermittent recruitment of good quality year-classes.
- Possibility that spawning does not occur every year.

As a result of this, the deep sea living marine resources have low productivity generally, so they cannot sustain but a low operating rate. Furthermore, when a depletion of these resources occurs, the recovery is expected to be long and it is not assured. The great depths where these living marine resources are caught by the DFP pose other scientists and technicians challenges to provide scientific support to management. All these factors make that both assessment and management are more expensive and exposed to greater uncertainty.

H. Authors' opinion in relation to the concept con vulnerable marine ecosystems.

i.- The vulnerability of stocks, communities and habitats is related to the probability that a stock, community or habitat experience a substantial alteration due to a short duration or chronic disturbance, the likelihood that it recovers and how long it takes.to recover.

ii.- In turn, these elements are related to the characteristics of ecosystems themselves, especially those relating to biological and structural aspects. The features of these complex ecosystems may be that they show physically or functionally fragile. The most vulnerable ecosystems are those that can be easily disturbed and have a very slow or no recovery,

iii.- The vulnerability of stocks, communities and habitats should be assessed in relation to their specific threats. Some geographic features, particularly those who are physically weak or naturally scarce, may be vulnerable to most forms of disturbance, but the vulnerability of some stocks, communities and habitats may vary greatly depending on the type of fishing gear used or the type of disturbance experienced.

iv.- The risks under which a marine ecosystem is, are determined by their vulnerability, the probability of suffering a threat and the means to counterbalance it.

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I. General comments on the "International Guide for management of these fisheries".

i.- The first part of the document summarizes the recommendations, resolutions and regulations of various international agencies on deep-sea fisheries in international waters aiming at ensuring as far as possible the long-term conservation of bottom ecosystems, which can be seriously impaired by the action of man.

ii.- These regulations come from both the General Assembly of the United Nations and the various Regional Fisheries Organizations, as well as agreements on the protection of biodiversity.

iii.- The second part is intended as a guide to how to transpose these regulations to the legislation of each country and illustrates it with examples of how certain countries have transposed these recommendations into their legislation.

iv.- In the case of Spain, it does not mean anything new as we have previously stated, for all regulations, as they enter into force, are first taken by the EU and are immediately transposed into the Member States national law.

v.- As for the definition of deep-sea fisheries, the statement " *Most deep-sea fishing occurs at a depth of at least 200 meters, but up to depths of as much as 2000 metres* " is ambiguous and should be specified, because although it is true that the deep-sea species are caught in that range of depths, it is also true that between 200 and 600 meters deep other fisheries take place in very important slope, as in the case of hake, monkfish, Norway lobster and other high value fisheries, which have a minimal impact on the ecologically sensitive species.

vi.- All measures to fight the IUU fishing have largely favored the compliant fleets such as ours especially over the recent lustrums, as they seek to discourage unfair competition. These measures include: *"Establishment and maintenance of a record of fishing vessels authorized to fish on the high seas" ,"Prohibition of flagging identified IUU vessels"," mandatory authorizations for fishing vessels operating on the high seas" , " market and trade regulations"* etc. They are widely recommended by the various competent bodies

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vii.- A definition from 600 meters would avoid these problems, but not another very important one that is the intention of the EU to implement this own regulation in international waters. For example, if it was applied in Newfoundland, that would be a serious problem indeed because most of the Greenland halibut fishery is carried out below 800 m depth.

viii.- On the other hand, when the problem of managing a deep sea fishery is approached the following statement is systematically introduced: *many deep-sea species are subject to slow growth, low reproductive rates and low natural mortality rate"*, which is immediately linked to the fact these species can only sustain very low exploitation rates, or not even that. Although deep sea species generally have slower growth, greater longevity and delayed sexual maturation (they tend to be more strategists than K) compared to short life pelagic species or shallower water demersal species, however, there is a great variability between them, ranging from cases of extreme longevity like orange roughy (Hoplosthetus) to other species such as the deep sea crustaceans like pink shrimp (Aristeus), or carabiner (Plesiopenaeus), in which cases the variables would resemble more to the species of shallow waters than to the Hoplothetus. This makes it possible to perfectly develop directed fisheries for some of them.

ix.- In the case of the Newfoundland Greenland halibut, its peculiar exploitation pattern can help the sustainability of the fishery. Indeed, even though they are long-life species their exploitation pattern in very marked "dome" make that fishery only impacts heavily on very few ages where the fishing gear is really effective. After overcoming these, the remaining stocks will suffer a very low exploitation rate.

x.- The long-term sustainability of deep sea stocks, as every stock exploited, will depend on the balance between the rate of change of the factors that increase biomass as is the case of the individuals weight growth, their renewal ability (maturation, individual fecundity, survival and recruitment) and possible final immigrations from neighboring stocks, and those causing biomass decrease such as the natural mortality, migration and mortality due to fishing, which will be characterized by the intensity each stock age is fished. Therefore, management of these stocks should follow the recommendation of regulating "*on a case-by-case basis and on a scientific basis, including the application of the precautionary approach*".

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xi.- Here it is important that the precautionary approach is applied, that is, if it is shown that the stock is able to sustain a fishery, there should be no objection to develop same.
As it has been said, among the deep sea stocks some are more vulnerable and some are less vulnerable. In our opinion, the fleets exploiting the deep sea resources should be characterized by the specific composition of their catches and the impact on the various "deep sea" species rather than by depth ranges. Otherwise, we will risk ending up applying burdensome measures to fleets that really have very little impact on the conservation of the species that are more vulnerable.

xii.- One way the problem could be addressed would be to see the proportion of these species in the annual catch of different fleets that work in the area. This proportion will coincide with the share of these fleets in fishing mortality of species. This way those fleets or fishing vessels whose cumulative mortality on vulnerable species does not reach for example 10%, may be exempted from the measures, which will release a large number of vessels whose catches are almost anecdotal, with the assurance that regulating and controlling the remaining fishing fleets with greater fishing activity, 90% of mortality will be controlled and regulated.

xiii.- If this system is implemented, regulators would be surprised to check that the longlines working below 600 meters have greater impact on deep-sea sharks than trawls. This is because trawls only "sweeps" the surface that lies between the fishing doors, which means that the species are caught in proportion to the species distribution in the ecosystem, while catchability of longline will depend on the species in question and those vulnerable to this fishing gear may be attracted from great distances and even within the same species it may impact some year classes (the most swimmers).

xiv.- As management measures for these stocks, the various organizations propose the classic "*catch and/or effort limitations*" and in some cases " *area-based management and conservation, including closing high seas areas for its vessels* " although these measures are more relate to the conservation of EMV.

xv.- Regarding the last point, there is a general recommendation to carry out "*Environmental impact assessments*" as a requirement prior to the authorization of a new deep sea fishery. This requirement also applied to the already existing authorizations and the RFMOS like NAFO and NEAFC took this resolution into consideration by establishing a map of the fishing footprint on the understanding

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that VMEs are unlikely to appear in an area where fishing activity have been carried for years . To this end, VMS positions provided by the contracting parte were of great help.

xvi.- This fishing footprint has been complemented with proven scientific information from ad-hoc campaigns designed to locate possible areas with VME or presence of vulnerable species in the sets of the research campaigns dedicated to evaluating stocks. Once shown that the new fishery is unlikely to affect VME, the fishery depth should meet the following requirements to contribute with detailed information on fishing operations ("*information on fishing operations, including vessel position, catch of target and non-target species, including through logbooks and VMS* ") and on control, inspection and enforcement ("*Establishment of a monitoring, control, surveillance, and enforcement system, including sanctions and a legal and administrative mechanism to identify serious violation"*, o *"transshipment regulations/authorization").*

xvii.- What is said in the previous paragraph means nothing new about what is required having in mind the EU Fishery Management requirements for medium and large size fishing vessels

xviii.- There is a general recommendation to reduce levels of by-catch "*Establishment of regulations to reduce by-catch*", which is already included in the new CFP and a UNGA resolution adopted by various organizations requesting the "*Regulation of design and use of fishing gear*". So far this has only resulted in the banning of trawl and/or gillnets below certain depths for example 1000 meters in the Mediterranean.

xix.- The prohibition of gillnets in EU waters below 600 meters and the recent ban on trawling below 800 meters in EU waters are not properly substantiated on technically scientific information. We have already approached above the problem arisen from depth-based regulations.

xx.- The vast majority of organizations state that to undertake the management of these fisheries a protocol must be established where catches of certain individuals are above certain levels "*Deep-sea fishing protocols, VME thresholds, indicator species, move-on rules ".*

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xxi.- The implementation of these protocols have several drawbacks. Firstly, limits are very difficult to establish, since different limits have to be fixed for different fishing gears working in the area since each of them has its own catchability of these organisms. Secondly, it may not be the same for different areas since the relative abundance of these species differ in each area.

xxii.- On the other hand though it is established, captains and masters are not trained to identify these organisms (sponges, cnidarians, polychaetes, bryozoans etc.), as they are species that can cause classification problems for experts. In addition, since they have no commercial interest, the easiest thing for the captain is to get rid of them and not to record anything in the log book, especially when we are aware that this may result in the closure of a given area. In fact we believe that in the years during which this protocol has been in force in NAFO and NEAFC, there has not been communicated any single finding of this type by the fleet. Moreover, these problems are used as an excuse to demand a 100% coverage of control observers.

xxiii.- The implementation of these protocols was agreed at the UNGA and has been automatically moved into the RFMO, but it makes no sense in many cases. For example, in NAFO, the whole area with fishing footprint has been mapped and all areas with significant presence of VME have been identified and closed. What is the point then to keep these protocols? If a sample encountering occurred, it is most likely to come from another area dragged by the tide or the seabed currents.

xxiv.- Therefore, the Spanish General Secretariat of Fisheries have long been fighting in the EU so that NAFO implements the precautionary approach and that this obligation is eliminated. This would allow the issue of the 100% control observers on fishing vessels to be also raised.

xxv.- Returning to a point that seems important to us, and which we believe is being applied only when it produces adverse effects on fisheries, refers to the fact that regulation of these fisheries must be undertaken "*on a case-by-case basis and on a scientific basis, including the application of the precautionary approach* ". This means that measures should not be general for all deep-sea fisheries, but should take into account the greater or lesser knowledge of ecosystems, their degree of vulnerability and the effectiveness of any mitigation measures of adverse effects that may be applied.

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xxvi.- Actions taken by Spain in the management of deep sea fisheries: Spain starts from a quite privileged situation because since 2005 it has completed a program of systematic mapping of fishing grounds where our trawlers work in international waters (see Annex). The scientific quality of this program has been recognized in various international organizations such as the EU, NAFO or ICES. The results of this program have made it possible to locate areas with significant presence of VME in these fishing grounds, which have been presented in various forums in order that appropriate mitigation measures are in place.

J. Colophon: Points highlighted by the authors of this report towards the near future:

i.- Research on VME carried out by Spain, especially by the IEO and unilateral actions of our fisheries administration have been recognized in various international forums and have defused a maneuver of NGOs and some countries (eg Norway), who enjoyed the sympathy of Commissioner Damanaki, aimed at banning fishing in international waters which were not regulated by an RFMO (Atlantic SW) considering that unregulated fishing were carried out in these areas . With the information available or by using general criteria the bodies mentioned in this report have established fishing exclusion zones on the assumption they were an issue. This way, it was intended to guarantee that the continuation of the fleets' activity in these fisheries had no significant negative effects on the VME. In this sense, in the South West Atlantic fishing grounds, where there is no RFMO regulating fisheries, Spain unilaterally closed the problematic areas to the fishing activity of its fleet based on the information available from its fleet with scientific observers from IEO on board and the in-depth analysis of the data collected. Now Spain can talk in various forums from the moral authority of being the first country (if not the only one) that has performed so strongly.

ii.- As culmination of this chapter, in our opinion based on the experience gained in many years of research and management, like our British colleagues say, it is important to remember to legislators from the various forums that in order to respect the UN, RFMOS and others agreements, regulations concerning the management of deep-sea fisheries are more appropriately made "*On a case by case basis and on a scientific basis, including the application of the precautionary approach* " .

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iii.- Therefore, it is important to apply the precautionary approach, but deep-sea fishing should not be permitted in there are clear signs of risk to biodiversity. Even so, if it is shown that the stock is able to sustain a fishery and that there are procedures to mitigate possible undesirable effects on EMV, there should be no objection to this provided that the appropriate standards of protection is dictated in each case.

iv.- The regulation of fleets exploiting deep sea stocks should be made taking into account the vulnerability of same. In our opinion, the fleets exploiting the deep-sea resources should be featured by the specific catch composition and its impact on deep-sea species, rather than by depth ranges. Otherwise, we risk applying burdensome measures to fleets that really have very little impact on the conservation of vulnerable species. So it could waive the application of certain harmful measures for fleets.

v.-. One way to address the problem would be to see the proportion of these ecologically sensitive species in the annual catch of different fleets that fish in the area. This proportion will coincide with the share of the fleet in the fishing mortality of these species. This way those fleets or ships whose cumulative mortality on vulnerable species does not reach, for example, 10% could possibly be exempted from restrictive to measures.
a large number of vessels whose catches of this species to be protected are practically anecdotal, would be free from unnecessary impairment with the assurance that by regulating and monitoring the rest of the fleets that fish more, the 90% of mortality will be controlled and regulated.

vi.- Banning trawling at depths greater than 800meters in EU waters by claiming the incidence of this fishing gear on deep sea elasmobranches makes no sense. If this system is implemented, regulators will surprisingly realize that, for example, longliners working at depths below 800 meters impacts on deep sea sharks more than trawlers. This is so because the trawler only "sweeps" the surface that lies between fishing gear doors, which means that species are caught in proportion to the distribution of same in the ecosystem while catchability of longlines will depend on the species in question, and those who are vulnerable to this fishing gear can be attracted from great distances. Even within one species it can affect year classes that achieve greater swimming speed.

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vii.- As management measures for these stocks, the various organizations propose the classic "*catch and/or effort limitations*" and in some cases "*area-based management and conservation, treats including closing high seas areas for its vessels*" although these measures are more related to the conservation of VME.

viii.- In relation to the previous point, the various RFMO have carried out the international agreement to make a general recommendation to carry out the so-called "*Environmental impact assessments*" as prior requirement to the authorization of a new deep-sea fisheries. This requirement was also applied to the existing RFMO such as NAFO and NEAFC, which adopted this resolution by establishing the fishing footprint maps on the understanding that VME are unlikely to appear in areas where fishing has taken place for years. VMS positions data provided by the contracting parties were very helpful for this purpose.

ix.-.The fishing footprint based on historical fishery background, has been supplemented with proven scientific information from ad-hoc campaigns designed to locating possible VME areas or the presence of vulnerable species in the research sets intended for stocks evaluation

x.- Once shown that the new fishery is unlikely to affect VME, it must comply with the following requirements on detailed information supply: *"Information on fishing operations, including vessel position, catch of target and non-target species, including through logbooks and VMS"*. And for control, surveillance and enforcement, "*Establishment of a monitoring, control, surveillance, and enforcement system, including sanctions and a legal and administrative mechanism to identify serious violation",* or *"transshipment regulations/authorization".*

xi.- This is not anything new to what is already required by EU Fisheries Administration for medium and large size fishing vessels. There is a general recommendation to reduce by-catch levels *Establishment of regulations to reduce by-catch*", which is already included in the new CFP.

xii.- In addition to the above there is a UNGA resolution that has been adopted by various organizations whereby "*Regulation of design and use of fishing gear*" is requested though so far it has resulted only in the ban on trawling gear and/or gillnets below certain depths, for example, below 1000 meters depth in the Mediterranean.

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xiii.- The reported ban on gillnets in EU waters at depth greater than 600 meters and the recent ban on trawling in EU waters below 800 meters as aforementioned, lacking a proven damage on ecologically sensitive species caused by its action in those depths will pose a serious problem to many fleets,. There might be more information and arguments than those used to defend the Spanish vessels affected by this issue in the Commission, the Council and the Parliament, even though the outcomes were similar.

xiv.- Finally, the vast majority of fisheries regulatory organizations provide that in order to manage these fisheries a protocol must be established if catches of certain species are above certain levels "*Deep-sea fishing protocols, VME thresholds, indicator species, move-on rules "*.

xv.- The implementation of these protocols have several operational problems (difficulty in establishing limits, complex identification of organisms, implementation difficulty). Firstly, the limits are very difficult to establish, because different limits must be set for different fishing gears working in the area. This is so firstly because each fishing gear has its own catchability of these ecologically sensitive organisms, secondly because limitations should not be the same for different areas, since the relative abundance of these species differ in each area, and thirdly because, even though it is so established, the captains and masters are not trained to identify these sessile invertebrates to which no greater attention was paid but to return them to the sea (Sponges, Cnidarians, Polychaeta, Bryozoans etc.) . It is often alien species that may even cause classification problems to experts in marine benthos. In addition, simply using common sense and experience on fishing vessels, given that they have no commercial interest it is easier for the captain to discard them and not to record anything in the log book, particularly considering that they are aware that this may result in the closure of a given area of fishing interest with or without a real scientific basis.

xvi.- We actually believe that during the years these protocols have been in force in NAFO and NEAFC, no finding of sedentary invertebrates species have been reported yet by any of the fishing vessels of the fleet. we would add to this that these problems are sometimes used as an excuse to demand a 100% coverage of scientists observers on board for the comprehensive monitoring of catches.

xvii.- The application of these protocols was agreed at the UNGA and has been automatically transposed to the RFMOs, but in many cases this application, in our

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opinion, does not make any sense. For example in NAFO the fishing footprint has been mapped in the whole area and all areas with significant presence of VME have also been identified and closed, which makes it meaningless maintaining and extending these protocols unnecessarily harmful for Spanish vessels.

xviii.- In view of all the above we know that the Spanish fisheries administration has been fighting in the EU for long time in order that the precautionary approach is applied and this obligation is removed in NAFO. If these well-based foundations were acknowledged by the majority in decision-making bodies, it would also allow reconsidering the need for a 100% coverage of control observers on fishing vessels, which in many cases do not meet a minimum return and those costs could be applied in questions that are more necessary for the research and management of these fisheries.

K. ANNEX.

A good example of scientific publications by authors from the Spanish Institute of Oceanography on Spanish researches of vulnerable marine ecosystems in the Atlantic Ocean can be seen in the Marine Policy journal under the title *"Actions taken by fishing Nations towards identification and protection of vulnerable marine ecosistems in the hight seas: The Spanish case (Atlantic Ocean)"*, the authors of which are Pablo Durán Muñoz, M. Sagayo Gil, FJ Murillo, J.L. River, L. J. Lopez Abellan. A PDF copy is sent in a separate mail.

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Actions taken by fishing Nations towards identification and protection of vulnerable marine ecosystems in the high seas: The Spanish case (Atlantic Ocean)

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ABSTRACT

In reply to the United Nations General Assembly Resolutions on sustainable fisheries, Spain, either by itself or in collaboration with other Nations, has been carrying out studies on vulnerable marine ecosystems (VMEs) in the high seas of the Atlantic Ocean (areas beyond national jurisdictions) since 2005. Such studies provide advice to the Spanish Government, the Regional Fisheries Management Organizations and the European Union. This paper presents the multidisciplinary methodology used and summarises the following management results: (i) contribution to identification of cold-water corals and provision of evidence to close part (~16,000 km^2) of the Hatton Bank (NE Atlantic) to bottom fishing; (ii) compilation of an international data base to identify VMEs on the slopes of the Grand Banks of Newfoundland, Flemish Pass, and Flemish Cap (NW Atlantic) and to redefine areas currently closed to fishing; (iii) improvement of knowledge about deepwater ecosystems on Walvis Ridge and adjacent seamounts (SE Atlantic) as a pilot project for implementation in this region; and (iv) identification of VMEs and closure of an area (~41,300 km^2) on the high seas of the SW Atlantic. Also discussed are progress and challenges related to identifying and protecting VMEs.

1. Introduction

1.1. Protection of vulnerable marine ecosystems within the framework of the United Nations

Nations with high seas bottom fishing fleets, such as Spain, are committed to protecting vulnerable marine ecosystems (VMEs). Such commitment is derived from the mandate of the United Nations General Assembly (UNGA) Resolutions 59/25 [1], 61/105 [2] and 64/72 [3] on sustainable fisheries, and was implemented from 2004 to 2009. These Resolutions urge fishing Nations and the Regional Fisheries Management Organizations (RFMOs) to identify and protect VMEs, and also to assess the impact of deep-sea fisheries in the high seas (areas beyond national jurisdictions). Progress on identification and conservation of VMEs within the framework of the UNGA, especially of cold-water corals and sponges, was evident right from the start of the process. There are, however, other issues that still need to be defined and dealt with. A workshop was held in September 2011, at the United Nations (UN) Headquarters in New York, to discuss (i) the implementation of Resolutions 61/105 and 64/72, especially the paragraphs related to adverse deep-sea fisheries impacts on VMEs, and (ii) the actions considered essential to avoid such adverse impacts. The objectives of the workshop were: (i) to review the experience of Nations and the RFMOs; (ii) to evaluate progress, difficulties experienced and future needs; and (iii) to lay the foundations for a new draft Resolution on sustainable fishing. The results from Spanish research on VMEs in the high seas were presented at the New York workshop.

1.2. Spanish research on VMEs and international collaboration

In 2005, Spain began research into high seas VMEs as a reply to the UNGA and the North East Atlantic Fisheries Commission (NEAFC)

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requirements to protect cold-water corals and to look for ways of improving deep-sea fisheries management on the Hatton Bank (NE Atlantic). This experience helped expand research progressively into other areas, wherein collaborations were established with other Nations and RFMOs.

Such research is being promoted by the General Secretariat for the Sea (SGM), of the Spanish Ministry of the Environment and Rural and Marine Affairs. The Spanish Institute of Oceanography (IEO) is responsible for the scientific aspects of these initiatives. The IEO is a public marine research body under the Ministry of Science and Innovation and advises the Spanish Government on Fisheries policies. It also represents the Spanish Government at international oceanographic and fisheries forums [4]. Four different regions of the Atlantic Ocean have been studied to date: (i) the research in the Northeast Atlantic (2005–2008) was carried out under the Spanish ECOVUL/ARPA project, led by the IEO [5] under the framework of cooperation with the SGM; (ii) the Southwest Atlantic research (2007–2010) was carried out under the Spanish ATLANTIS [6] project, once again under the guidance of the IEO and with cooperation from the SGM; (iii) Scientific research in the Southeast Atlantic (2008–2010) was carried out under the Spanish RAP-SUR (IEO) in active collaboration with the Namibian NatMIRC [7]; and (iv) the international NEREIDA programme [8] was established within the framework of the Northwest Atlantic Fisheries Organization (NAFO), in order to boost research into the Northwest Atlantic VMEs (2009–2010). This programme is led by Spain (IEO, SGM), with active participation from Canada (DFO, GSC), the United Kingdom (CEFAS) and the Russian Federation (IO-RAS, PINRO) [9].

1.3. Objective of this paper

The aim of this paper is to summarise actions undertaken by Spain in the Atlantic Ocean, either on its own or in collaboration with other Nations, on the subject of identifying and protecting VMEs in the high seas. The multidisciplinary methodology used to identify VMEs and select areas for protection is presented here. High seas fisheries management results are likewise summarised, with special reference to areas closed to bottom fishing. This is followed by a discussion on the issues related to the protection processes carried out within the UN framework, especially progress made, difficulties experienced, and challenges faced when implementing the UNGA Resolutions. The conclusions from the Spanish experience are then briefly outlined.

2. Study areas

The Hatton Bank is located in the high seas[1] of the Northeast Atlantic Ocean, to the west of the British Isles, and within the NEAFC Regulatory area. The study area (Fig. 1A) corresponds to the western slope of the Bank, where the Spanish high seas freezer trawler fleet operates. There is a Spanish multispecies deep-sea bottom trawl fishery in the area, mainly directed towards roundnose grenadier and smoothheads, at depths greater than 1000 m.

The Grand Banks of Newfoundland is located in the Northwest Atlantic Ocean, to the east of the Canadian coastline. The main deep-sea fishing grounds are located on the high seas within the NAFO Regulatory area. The study area (Fig. 1B) corresponds to the slopes of the Grand Banks and the Flemish Cap, and also includes bottoms that separate the two submarine features (the Flemish Pass). The Spanish high seas freezer bottom trawler fishery operates in this area, and is principally directed towards Greenland halibut, at depths greater than 700 m.

The Patagonian shelf and adjacent slope are located to the east of the South American continent, in the Southwest Atlantic Ocean, where there are currently no RFMOs established. The study area is situated on the high seas,[2] to the east of the Argentine EEZ and to the north of the Falklands conservation zone, between Latitude 42°S–48°S (Fig. 1C). The study area covers part of the continental shelf and upper slope and extends to the middle slope up to ~1500 m depth. The Spanish high seas freezer bottom trawler fleet operates in these waters to fish mainly hake and shortfin squid, at depths less than 300 m.

The Walvis Ridge is located in the Southeast Atlantic Ocean, to the west of the Namibian coastline. Deep-water fishing activity on the high seas is irregular (currently low) and is managed by the South East Atlantic Fisheries Organization (SEAFO). The study area (Fig. 1D) is located in the high seas[3] between 200 and 3000 m depths on the Valdivia Bank and along the adjacent seamounts (Ewing Seamount).

3. Multidisciplinary methodology

Scientific research was conducted following International Guidelines for the management of deep-water fisheries in the high seas [10]. The VMEs study required participation by specialists from many disciplines: (i) Conventional fisheries science; (ii) Geology; (iii) Benthic Ecology; (iv) Sedimentology; and (v) Hydrography. The multidisciplinary methodology used (Table 1) was the one described by Durán Muñoz et al. [5]. A summary of sampling characteristics is shown in Table 2.

The commercial high seas fisheries footprint was identified using fishing effort data obtained through (i) observers onboard commercial fishing vessels and/or (ii) the vessel monitoring system (VMS).

The science-industry cooperative surveys carried out using commercial fishing vessels enabled the study of: (i) the effects of bottom fishing gears [11] and (ii) the distribution of VMEs indicator species. The inclusion of data collected in cooperation with stakeholders into the advisory process is an important element to improve stakeholder understanding, degree of acceptance and the potential for success of conservation measures (e.g. areas closed to fishing). The multidisciplinary scientific cruises carried out onboard the multipurpose oceanographic vessels [12] owned by the SGM (the *R/V Vizconde de Eza* and the *R/V Miguel Oliver*) facilitated collection of: (i) geophysical information (bathymetry and backscatter using the Simrad EM-302 multibeam echosounder and very high resolution seismic profiles using the Topas PS018 parametric sub-bottom profiler); and (ii) data on composition and distribution of benthic communities (using bottom trawls, rock dredges and box corers). The multibeam research was carried out following International Hydrographic Organization guidelines [13]. Bathymetric and backscatter maps facilitated study of geomorphology and seabed characteristics. Seismic profiles provided information about the substrate. Dredge samples supported geophysical studies. Surface sediments (obtained using box corers) were used to calibrate backscatter data and create sediment maps, which

[1] Ireland, the United Kingdom (31 March, 2009), and Denmark (2 December, 2010) submitted to the CLCS, information on the limits of the continental shelf beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.

[2] Argentina (21 April, 2009) and The United Kingdom (11 May, 2009) submitted to the CLCS, information on the limits of the continental shelf beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.

[3] Namibia (12 May, 2009) submitted to the CLCS, information on the limits of the continental shelf beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.

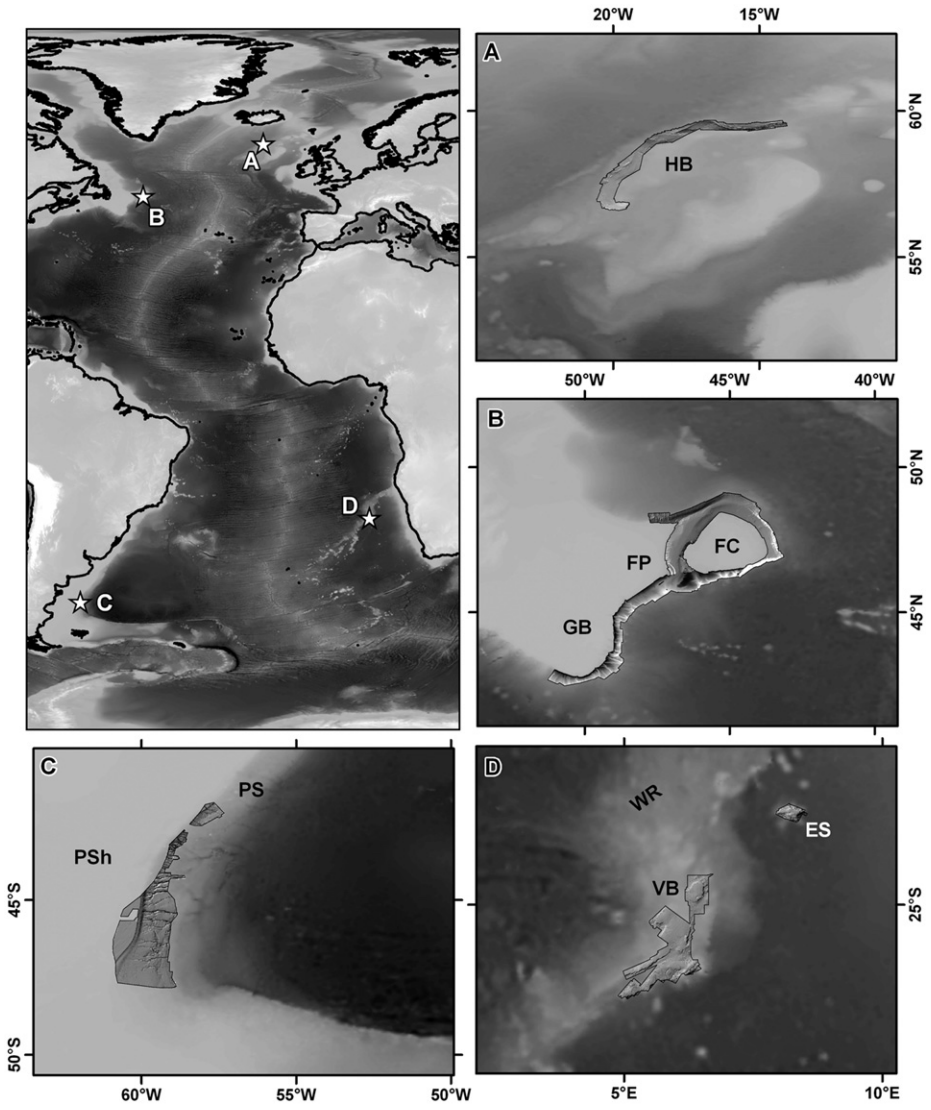

Fig. 1. Locality map showing the four study areas (white stars) along the high seas of the Atlantic Ocean. Details of areas covered with multibeam echosounder (multibeam bathymetry) are as follows: (A) Western slope of the Hatton Bank; (B) Slopes of the Grand Banks of Newfoundland, Flemish Pass and Flemish Cap; (C) Part of the Patagonian shelf and slope; (D) Valdivia Bank and Ewing Seamount (Walvis Ridge). HB, Hatton Bank; GB, Grand Banks of Newfoundland; FP, Flemish Pass; FC, Flemish Cap; PSh, Patagonian Shelf; PS, Patagonian Slope; WR, Walvis Ridge; VB, Valdivia Bank; ES, Ewing Seamount. Note that scales are not the same in all maps. General bathymetry was obtained from ETOPO [30].

Table 1
Multidisciplinary methodology used to study vulnerable marine ecosystems in the high seas: disciplines, their role and related sampling methods.

Discipline	Role	Sampling methods
Conventional Fisheries Science	Fishery footprint (spatial distribution of fishing effort); Distribution of VME indicator taxa; Effects of bottom fishing gears on VMEs; Survey indexes	Observers onboard commercial vessels; Vessel monitoring system; Multidisciplinary scientific bottom surveys; Science-industry cooperative bottom surveys
Geology	Seabed mapping; Bathymetry and backscatter; Identification of main geomorphological features and associated geohabitats	Multibeam (EM-302); Sub-bottom profilers (Topas PS-180); Box-corer and rock-dredge
Benthic ecology	Deep-sea benthic ecosystem structure and function; Definition of benthic communities. Monitoring of fishing effects	Bottom surveys; Box-corer and rock-dredge; Aggregation techniques, indicators; Video, photograph and ROV
Sedimentology	Integration of sediment characteristics in seabed maps; Calibration of backscatter data	Box-corer, rock-dredge and net collectors; Sediment analysis
Hydrography	Study of hydrographical conditions	CTD
Visual ground-truth validation	Observation (*in situ*) of the seabed and benthic communities; Study of impacts; State of conservation of VMEs	Video, photograph and ROV

in turn helped locate benthic communities. Benthic assemblages were determined using aggregation techniques and survey databases [5]. Whenever possible, CTD probes were used to study hydrographical conditions. Depending on availability, direct observation methods (video, photography, Remote Operated Vehicles—ROV) were further used to obtain *in situ* images of the benthic ecosystems and record their conditions. The above was done using two platforms: (a) the Spanish research vessel *R/V Miguel Oliver* in the SW Atlantic and

Table 2
Summary of studies carried out by Spain on vulnerable marine ecosystems in the high seas of the Atlantic Ocean. Sampling activities and management results are presented (n.a.=data not available).

Characteristic	ECOVUL/ARPA	ATLANTIS	RAP-SUR	NEREIDA
Field works period	2005–2008	2007–2010	2008–2010	2009–2010
Participants	Spain[a]	Spain[b]	Spain, Namibia	Spain, Canada, U.K., Russia
Research vessels	*R/V Vizconde de Eza*; *R/V Miguel Oliver*	*R/V Miguel Oliver*	*R/V Vizconde de Eza*	*R/V Miguel Oliver; CCGS Hudson*
Management objective	Development of a multidisciplinary methodology to study VMEs in the high-seas. Identification of cold-water coral areas in the Hatton Bank and selection of protection areas	Identification of VMEs in the high-seas of the SW Atlantic. Selection of protection areas. Data collection for fish stock assessments	Experimental study to locate and characterise VMEs associated with seamounts in the SEAFO Regulatory Area	Review of areas currently closed within the NAFO Regulatory area. Identification of new VMEs areas
Study area and depth range	Western slope of Hatton Bank (NE Atlantic) ~1000–1500 m	Part of the Patagonian shelf and slope (SW Atlantic) ~200–1500 m	Valdivia Bank and Ewing Seamount (Walvis Ridge) (SE Atlantic) ~200–3000 m	Slopes of the Grand Banks of Newfoundland, Flemish Pass and Flemish Pass (NW Atlantic) ~700–2000 m
Fisheries and fishing depth	Multispecies bottom trawl deep-sea fishery for grenadiers and smoothheads (> 1000 m)	Bottom trawl shallow fishery for hakes and shortfin squids (< 300 m)	Experimental and sporadic pot and bottom longline fisheries for deep-sea red crabs and fish (e.g. Patagonian toothfish) (> 300 m)	Bottom trawl deep-sea fishery for Greenland halibut (> 700 m)
RFMO Regulatory Area	NEAFC	n.a.	SEAFO	NAFO
Related working groups and advisory bodies	ICES-NAFO WGDEC, ICES ACOM	n.a.	SEAFO SC and SSC	ICES-NAFO WGDEC, NAFO WGEAFM, NAFO-WGFMS; NAFO SC
Multibeam bathymetry (km^2)	~18,760	~59,105	~15,823	~ 68,900
Very-high resolution seismic profiles (km)	~1121	~91,905	~1455	~18,606
Scientific trawl sets	38	413	63	~2500
Rock dredges	22	102	15	104
Box corers	13	209	n.a.	341
CTD	n.a	519	136	~414
Visual ground-truth validation	n.a	Photo/video ROV	n.a.	Photo/video ROV
Fishery footprint. Number of bottom trawls and period analyzed	3675 (1996–2006)	12,788 (1989–2010)	1267 (1996–2007)	Data obtained from NAFO
Science-industry cooperative surveys	Longline/trawl	Longline/pots	Longline/pots	n.a.
Management results obtained/expected	Hatton Bank closed area (~16,000 km^2)	SW Atlantic closed area (~41,300 km^2)	Analyzing the suitability of using predictive models obtained from scientific research	International VME data base. Redefining the boundaries of NAFO closed areas (e.g. sponge fields). Identification of new VMEs

[a] Scientists from U.K. (BGS), Portugal (IPIMAR), participated in the Hatton Bank scientific expeditions.
[b] Scientists from Argentina (INIDEP) participated in the SW Atlantic scientific expeditions.

(b) the Canadian vessel *CCGS Hudson* in the NW Atlantic (Canada's contribution to the international NEREIDA programme [9]).

4. Results

4.1. Hatton Bank

The footprint of the Spanish bottom trawl fishery (1996–2006 period) was mainly located on the western slope of Hatton Bank, at depths between ~1000 and 1500 m. Cold-water coral ecosystems [5] and morphological features [14] were identified in the area. The International Council for the Exploration of the Sea (ICES), based on scientific literature and research carried out by Spain and the United Kingdom, suggested that the NEAFC and the European Union (EU) close part of the Hatton Bank to bottom fishing, in order to protect corals. The total area closed amounts to ~16,000 km^2, and lies at depths that range from 500 to ~1500 m (Table 2). Such closure is due for review in 2011 [15,16]. New bycatch data of VMEs indicator species obtained through collaboration with fishers suggests the need to extend the boundaries of the areas currently closed to fishing [9,11]. Such information is being included in the recently created VMEs data base of the ICES working group on deep-water ecology (WGDEC) [9]. This information will contribute to improving knowledge on the distribution of Hatton Bank VME indicator species, especially cold-water corals.

4.2. Grand Banks of Newfoundland, Flemish Pass and Flemish Cap

In 2009, the NAFO closed several areas to bottom fishing within the NAFO Regulatory area [17], based on information about "candidate VMEs areas" provided by groundfish surveys carried out by Spain/EU [18,19] and Canada. The international NEREIDA programme data base has contributed substantially to increasing knowledge on the VMEs of the Grand Banks of Newfoundland, Flemish Pass and Flemish Cap, and especially of cold-water corals and sponge grounds. The NEREIDA information is essential to provide advice on VMEs within the framework of the NAFO working groups. Results from this programme will hopefully redefine the current limits closed to fishing (11 closed areas) and also identify new candidate VMEs areas outside the groundfish survey areas (Table 2). VMS data were used to show level of fishing impact. The initial data from the international programme will help redefine the protection area of the sponge grounds in Sackville Spur [9].

4.3. Patagonian shelf and slope

Spanish bottom trawl fisheries studied (1989–2010 period) on the high seas of the SW Atlantic revealed that 99% of the historical fishing effort was carried out at depths less than 300 m because the main targets were hake and shortfin squid [6]. Both species are generally distributed on the continental shelf and on the upper slope, and are therefore not strictly considered as deep-water species. VMEs were studied at depths of approximately 200–1500 m. The obtained data has great scientific value because this is a poorly studied area. Nine large areas with presence of VMEs were identified and designated as candidate areas for closure to bottom fishing [20,21]. The closure proposal was made public in April, 2011, in Madrid (Spain), at an international meeting organised by the SGM with collaboration from the IEO, and where representatives from the EC, the FAO, the NGOs, the fishing industry, etc. [22] were also present. Based on the scientific advice, the Spanish Government implemented a fishing closure for the Spanish bottom trawling fleets in the high seas of the southwest Atlantic on 1 July 2011. The current closed area amounts to ~41,300 km^2 (Table 2).

4.4. Walvis Ridge and adjacent seamounts

In 2010, the SEAFO revised the previously established closed areas (2006) upon taking into account the historical fishing footprint provided by Spain for the period 1996–2007 [23]. Eleven seamounts or areas with seamounts were closed, under the consideration that most of them were either unfished or lightly fished. The three multidisciplinary research surveys conducted at the Ewing and Valdivia Bank (Walvis Ridge) seamounts in open areas were designed as an experimental study to locate and characterise VMEs associated with seamounts in the SEAFO region (Table 2), where the aim was to identify a feasible procedure for application throughout the SEAFO region. Predictive distribution (potential) models are being used with the obtained data to develop a GIS model for the area. Depth, slope, orientation and substratum seem to be the variables that affect distribution (by spots) of VMEs indicator species at these locations.

5. Discussion

5.1. The UN as the promoter of the protection process

The need for complying with the UNGA Resolutions mandate, especially Resolution 61/105 [2], has motivated the RFMOs to reorient part of their activities towards conservation of VMEs. Simultaneously, and in order to respond to international commitments and the demand for advice, some Nations financed and carried out research on VMEs following FAO International Guidelines [10]. This suggests that the work of international agents (Nations, RFMOs, NGOs, FAO, etc.) carried out within the framework of the UN process is useful for boosting sustainability improvements of deep-sea fisheries in the high seas.

5.2. Multidisciplinary studies as tools for the identification of VMEs

Identification of VMEs requires knowledge of (i) the geological characteristics of the seabed; (ii) the benthic communities that live there; and (iii) the spatial distribution and intensity of fishing effort and its potential impacts. In the Spanish case, research initiated on the Hatton Bank [5] served as a pilot experience to fine-tune a method for the multidisciplinary study – described as adequate by the FAO [24] – in order to respond to the information void. Research based on multibeam echosounder data allows identification of mega-habitats (e.g. coral reefs, rocky outcrops, drifts) but with some limitations (e.g. identification of coral gardens). Such methodology was progressively improved thanks to (i) experience acquired in other Atlantic areas; (ii) a more intensive sampling programme, (iii) availability of new sampling technologies (e.g. ROV); and (iv) international collaboration.

5.3. Progress in the identification and protection of VMEs

Results presented in this paper indicate that significant progress has been made towards compliance with paragraphs 83b and 83c of Resolution 61/105, particularly in relation to mapping, identification and/or protection of VMEs in the high seas,[4] both in areas regulated by RFMOs (e.g. NAFO, NEAFC and SEAFO), as well as in areas where these organizations are absent (e.g. the SW Atlantic). However, as

[4] Claims for extending national jurisdictions need to be taken into account when analyzing the role of international actors such as coastal countries and multilateral institutions, in the management of deep-sea benthic ecosystems.

stated by Durán Muñoz and Sayago-Gil [25] in the case of the Hatton Bank, the protection process has generally been slow and therefore there is a need for considering means of speeding up the process.

5.4. Need for completion of impact assessments

Key elements of impact assessments are provided by the FAO International Guidelines [10]. Nevertheless, and save for some exceptions (such as CCAMLR, SPRFMO, etc.), there does not seem to be a clear consensus on impact assessment protocols, particularly on how any technical assessment should be carried out. This is probably one of the reasons why such an assessment has not been systematically carried out within the framework of some of the RFMOs. Therefore, there arises a need for all RFMOs to provide fishing Nations with clear and precise impact assessment protocols, in order to facilitate assessments and improve compliance with paragraph 83a of Resolution 61/105 [2] (reaffirmed at paragraph 119a of Resolution 64/72 [3]).

5.5. Advantages of having RFMOs

As already shown in the cases of the NE, NW and SE Atlantic, the presence of RFMOs facilitates implementation of VMEs protection measures. In these cases, the advisory bodies (such as Scientific Councils, Working Groups and Advisory Committees) are the multilateral forums that provide, analyse and discuss scientific data (e.g. data from the ECOVUL/ARPA, NEREIDA and RAP-SUR projects). They likewise promote collaboration between Nations (e.g. the international NEREIDA programme). Information on VMEs was key to preparing advice. Therefore, the competent authorities were able to bring into effect conservation (e.g. closed areas to fishing) and monitoring (e.g. VMS) measures [15–17] based on scientific advice.

5.6. Disadvantages of not having RFMOs

The non-existence of RFMOs (as in the case of the SW Atlantic) would mean absence of clearly identifiable multilateral forums for providing and debating scientific data (such as the ATLANTIS project), in order to prepare advice and agree on regulatory measures. International agreements and collaborations would likewise be seriously hampered by the absence of RFMOs. In these cases, and in order to be coherent with the UNGA Resolutions, Nations should bring into effect individual regulatory measures of the type already implemented by the EU [26] and Spain. However, unilateral measures are only binding on the fleet from a particular country, and therefore would not be very effective in protecting VMEs if the other actors of the fishery did not implement similar measures. When the same regulatory measures are not universally applied, then fishers from the country that solely enforces the measures find that such measures: (i) are ineffective and (ii) are discriminatory since they are contrary to their own economic interests. The above and the absence of multilateral control mechanisms are factors that do not contribute to understanding the utility of such measures and discourage their compliance.

5.7. Alternate methods for the identification of VMEs

The efficiency of the "encounters" based methodology for identifying VMEs is up for debate due to the following reasons: (i) the methodology is applied only to corals and sponges; (ii) poor spatial resolution of commercial bycatch data [5]; (iii) current threshold values for defining "encounters" [17,27] generally seem to be quite high when compared to the catchability of the indicator species; (iv) threshold values are not always scientifically based due to absence of specific studies; and (v) in certain cases, thresholds have been calculated for one region but adopted for a different region altogether without analysing the specificities for that new region (e.g. from NAFO to SEAFO). The final aim of the "encounters" based methodology is to locate VMEs from evidence, which is characteristic for each zone, each indicator taxa and each fishing method. Therefore, thresholds that have not been adjusted to the three mentioned parameters decrease the efficiency of the "move-on rule" as a conservation measure. The "move-on rule" can even lead to undesirable effects (e.g. displacement of fishing effort to even more vulnerable zones than the ones intended for protection). Despite the limitations of the "encounters" based method [28], it still continues to be essential for identifying VMEs because of the huge cost (money and time) involved in mapping large areas and the impossibility of mapping the entire seabed. This suggests the need for research in order to fine-tune the definition of "encounters" for the different regions and fishing methods.

Predictive habitat models [29] can be a good aid for RFMOs to identify potential VMEs distribution zones, but the accuracy of predictions needs to be improved (e.g. false positives in the NAFO Regulatory area). There is no doubt that prediction models are conditioned by quality of input information (e.g. terrain, hydrographic, chemical, and biological variables). There are many high seas areas with either no information or very little information available on certain variables, and furthermore such information lacks the minimum desired quality. Whenever models are based on detailed smaller-scale studies, any extrapolation of these models to extensive areas will be conditioned by scale, precision, and accuracy of the variables used to model such areas.

5.8. Dynamic protection measures

The present experience suggests that VMEs protection measures should not be permanent but should be reviewed and updated as scientific knowledge progresses. This is applicable to the limits of closed areas as well as to threshold values for "VMEs encounters". Generally speaking, the efficiency of areas closed to fishing can be improved through redefinition of their geographic boundaries by (i) carrying out *ad hoc* multidisciplinary research (e.g. the NEREIDA programme) and (ii) obtaining information through collaboration with fishers (e.g. the ECOVUL/ARPA project). In the same manner and as stated earlier, the efficiency of threshold values can be improved by calculating their values on a case-by-case basis by carrying out specific studies and by taking into account the specificities of each ecosystem and metier.

6. Conclusions

There has been "good news" lately on the subject of implementation of the UNGA Resolutions on sustainable fishing, especially regarding the identification and protection of VMEs on the high seas. However, there still remain important issues to be resolved, such as defining impact assessment protocols, completing impact assessments, adjusting geographic boundaries of protected areas, and improving the definition of an "encounter".

Efforts made by international agents within the UN process framework have been quite successful in stimulating progress of high sea fisheries management. This positive message is an incentive to continue ongoing research and to take on new challenges.

RFMOs are essential instruments for regulating deep-sea fisheries in the high seas and for facilitating international collaboration. International advisory scientific committees are essential for compiling scientific knowledge and for drafting advice required to underpin management measures.

VMEs research carried out by Spain (either by itself or in collaboration with other Nations), can be considered as examples of *ad hoc* actions carried out by a fishing Nation to contribute to the implementation of Resolutions 61/105 and 64/72. The scientific data obtained has improved our knowledge of high seas VMEs and has led to the proposal and/or implementation of protection measures. Although such multidisciplinary scientific research was adequate for studying the VMEs issue, it however did not resolve all concerns regarding deep-sea fisheries impacts in the high seas. Nevertheless, it has been an important step forward in terms of the ongoing improvement of fisheries regulation and international collaboration.

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Glossary

ACOM: Advisory Committee;
ATLANTIS: Study of vulnerable ecosystems and fisheries in the SW Atlantic;
BGS: British Geological Survey;
CCAMLR: Commission for the Conservation of Antarctic Marine Living Resources;
CEFAS: Centre for the Environment, Fisheries and Aquaculture Science;
CLCS: Commission on the Limits of the Continental Shelf;
CTD: Conductivity, temperature and depth;
DFO: Department of Fisheries and Oceans;
ECOVUL/ARPA: Study of vulnerable ecosystems and their relationships with fishing gears;

EC: European Commission;
EU: European Union;
EEZ: Economic exclusive zone;
FAO: Food and Agriculture Organization;
GSC: Geological Survey of Canada;
ICES: International Council for the Exploration of the Sea;
IEO: Spanish Institute of Oceanography;
IPIMAR: Research Institute for Fisheries and the Sea;
INIDEP: National Institute for Research and Fisheries Development;
NAFO: Northwest Atlantic Fisheries Organization;
NatMIRC: National Marine Information and Research Centre;
NEAFC: North East Atlantic Fisheries Commission;
NEREIDA: NAFO potential vulnerable marine ecosystems impacts of deep-sea fisheries;
NGO: Non-governmental Organization;
IO–RAS: P.P. Shirshov Institute of Oceanology–Russian Academy of Sciences;
PINRO: Polar Research Institute of Marine Fisheries and Oceanography;
RAP-SUR: Deepwater resources in the southern hemisphere;
RFMO: Regional Fisheries Management Organization;
ROV: Remote operated vehicle;
SA MAR-ECO: Patterns and processes of the ecosystems of the southern mid-Atlantic ridge;
SEAFO: South East Atlantic Fisheries Organization;
SC: Scientific Council/Scientific Committee;
SSC: Sub-Committee of Scientific Committee;
SGM: Spanish General Secretariat for the Sea;
SPRFMO: South Pacific Regional Fisheries Management Organization;
U.K.: United Kingdom;
UN: United Nations;
UNGA: United Nations General Assembly;
WGDEC: Working Group on Deep-water Ecology;
WGEAFM: Working Group on Ecosystem Approach to Fisheries Management;
WGFMS: Working Group of Fishery Managers and Scientists on Vulnerable Marine Ecosystems;
VMEs: Vulnerable Marine Ecosystems;
VMS: Vessel Monitoring System.